Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Facilitating Opportunities for Flexible, Efficient and Reliable Spectrum Use Employing Cognitive Radio Technologies	)	ET Docket No. 03-108

COMMENTS OF VERIZON WIRELESS

Verizon Wireless hereby submits its initial comments in the above-referenced proceeding, in which the Commission seeks comments on proposals to "facilitate opportunities for flexible, efficient and reliable spectrum use employing cognitive radio technologies."[1]

The *NPRM* posits an illusory need for the *government* to promote cognitive radios to increase spectrum efficiency. Cognitive radios already are deployed in mass quantities today, because commercial wireless companies with licensed spectrum have exploited their rights to use current spectrum to the fullest. The Commission should terminate its inquiry into whether it should allow "non-voluntary" invasion of spectrum licensed on an exclusive, flexible use basis and increase permitted unlicensed power levels in licensed bands. Adopting such policies in the face of clear economic and technical harms and no apparent benefits would be misguided. Instead, if it truly wishes to promote cognitive radios, the Commission should reaffirm protections for licensees against interference and give licensees further flexibility under the Commission's innovative Secondary Markets initiative to share spectrum.

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[1] *Facilitating Opportunities for Flexible, Efficient and Reliable Spectrum Use Employing Cognitive Radio Technologies, Authorization and Use of Software Defined Radios,* ET Docket 03-108, 18 FCC Rcd. 26859 (2003), Notice of Proposed Rulemaking at ¶ 7 ("*NPRM*" or "*Cognitive Radio NPRM*").

I. The Commission Should Continue Its Policy of Letting Markets and Not Regulators Determine the Highest and Best Use of Spectrum

The *Cognitive Radio NPRM*, like the *Interference Temperature NOI*,[2] proposes to invade licensed spectrum under the guise of promoting technical innovation and filling white spaces. The Commission soft-pedals its proposed invasion, calling it "non-voluntary third party access to spectrum." But its meaning is clear – the Commission would forcibly reallocate rights to use radio spectrum from one set of users (licensees, their equipment manufacturers, and their subscribers) to another set of users (unlicensed users and their equipment makers), replacing a competitive market process with an administrative determination of how spectrum sharing should work. This contradicts everything the Commission has said about the superiority of "flexible" use and market competition over administrative spectrum management.

The Commission lists the forced taking of spectrum as the fourth of four ways that cognitive radio technology can improve spectrum access and efficiency. But the first three areas for inquiry the Commission identifies require no government intervention at all – cognitive radios to increase spectral efficiency (1) internally within a licensee's system; (2) as the result of a voluntary agreement between a licensee and a third party; and (3) as a means to facilitate automated frequency coordination among licensees of co-primary services.[3] Private parties with

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[2] *Establishment of an Interference Temperature Metric to Quantify and Manage Interference and to Expand Available Unlicensed Operation in Certain Fixed, Mobile and Satellite Frequency Bands*, ET Docket 03-237, Notice of Inquiry and Notice of Proposed Rulemaking, 18 FCC Rcd 25309 (2003) ("*Interference Temperature NOI*"). Verizon Wireless respectfully requests that its comments in that proceeding (filed Apr. 5, 2004) be made a part of this record and has attached them hereto ("Verizon Wireless Comments").

[3] *NPRM* at ¶ 3. Spectrum sharing among co-licensees may be possible in some bands, however, it would not be possible for CDMA carriers to share frequencies on a co-primary basis with other services on an automated basis. With CDMA the entire CDMA carrier is always in use if any one of the possible 40 or so single users that can operate on a single carrier is using it. Also in wireless services, devices operating

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licensee rights already do much of this, and will do more if the Commission adopts more flexible secondary market rules. As Verizon Wireless noted in its recently submitted comments in the Interference Temperature proceeding, the Commission's longstanding policies increasing licensee flexibility and the role of market forces in spectrum management have enabled licensees to deploy new methods and technologies to manage and control access and interference and quite efficiently serve a large number of customers. Verizon Wireless optimizes the use of its spectrum by, among other things, deploying CDMA.[4] For example, CDMA transmitters adjust power levels 800 times per second – to ensure that only the minimum power necessary is used to maintain a connection.[5] As the Commission itself states in the *NPRM,* "CDMA networks incorporate cognitive capabilities to allow more efficient use, *although there is no requirement to incorporate such capabilities.*"[6] It was precisely this lack of a regulatory requirement to install a specific technology, coupled with licensee's exclusive rights to mine its spectrum, that has spurred mass adoption of radios with cognitive capabilities – 39 million by Verizon Wireless customers alone.

This begs the question as to why the Commission even needs to raise the fourth area of inquiry into enabling cognitive radios' "non-voluntary" sharing of spectrum. As the Commission notes, the *NPRM* "is complementary to other Commission proceedings considering

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in close proximity to the base stations and mobiles used by the other co-licensee would cause adjacent channel interference and receiver front end overload problems.

[4] *See gen.* Comments of Thomas Hazlett and Matthew Spitzer to *Interference Temperature NOI* (filed Apr. 5, 2004) ("Hazlett and Spitzer"); *see also* Comments of V-Comm L.L.C. to *Interference Temperature NOI* (filed Apr. 5, 2004) at 42-44, 50-51 ("V-Comm Comments").

[5] *See* Verizon Wireless Comments, Exhibit A, Declaration of Charles Jackson at 7 ("Jackson Declaration").

[6] *NPRM* at ¶ 11 (emphasis added).

specific uses of cognitive radio technologies," including interference temperature.[7] The Commission's request for comment in the *Cognitive Radio NPRM* is more sweeping than that in *the Interference Temperature NOI* because it is not limited to any apparent interference cap and would encompass all bands where unlicensed is currently permitted to operate, including many licensed bands. Nonetheless, the technical, economic and legal analysis for the *NPRM* is the same as for the Interference Temperature proceeding. Verizon Wireless thus incorporates its comments in the Interference Temperature proceeding into the record here.

Forced Sharing Schemes Inevitably Will Increase Interference to Existing Licensees. Cognitive radios cannot magically solve interference problems where there is no private owner of spectrum. As Verizon Wireless and its technical consultants noted in their *Interference Temperature NOI* comments, there is no way even for brilliant cognitive radios to overcome fundamental physics – noise levels and interference depend on where the transmitter and receiver are, and vary from one moment to the next.[8] Among the problems:

- There may be a clear transmission path between a licensed base station and a licensed mobile unit, but an obstructed path between the base station and the cognitive radio device or an obstructed path between the mobile unit and the cognitive device. The cognitive radio device would read the channel as clear and begin transmitting, causing the licensed base station or mobile receiver to lose its connection.

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[7] *NPRM*, footnote 4. The sharing regime that the Commission proposed in the *Interference Temperature NOI* was roundly criticized by the vast majority of commenters to that proceeding. *See* "Firms Stress Risks of FCC"s Interference Temperature Model," *Communications Daily* (Apr. 7, 2004) at 2-6.

[8] V-Comm Comments at 31, 47-51; Jackson Declaration at 17-19.

- Unlicensed devices, like any other radio, cannot sense the channel status while transmitting. Licensed services cannot readily access spectrum since the unlicensed device will not readily relinquish the channel.
- The Commission's cognitive radio concepts are incompatible with CMRS licensees' cognitive radio technology. In order to optimize call quality, CMRS systems use a variety of methods to sense interference levels from other callers on channels before assigning channels to users. These systems would detect transmissions from unlicensed devices and would therefore block channels from use thereby obstructing service to licensees' customers.
- Unlicensed cognitive radios would have a very difficult time distinguishing between noise, including signals from unlicensed devices, and actual wireless traffic. CDMA base stations, for example, may transmit over 40 channels, and an unlicensed device would have to pick up all 40 signals – in other words, perform more or less the same reception function as 40 licensed CDMA devices.

For these and other reasons stated in the Jackson Declaration and in the V-Comm Comments in the Commission's Interference Temperature proceeding, promoting unlicensed cognitive radios in licensed bands will lead to increased interference with CMRS services. The result, as Verizon Wireless has explained, would be to force licensed carriers to spend billions just to cope with interference and degraded service quality.[9] The substantial costs of doing so would impair a licensee's ability to deploy new services to meet customers' demands.

[9] Verizon Wireless Comments at 9, 12; Hazlett and Spitzer at 36-41.

The Commission Should Not Raise Power Levels in Part 15. Even at current power levels, Verizon Wireless and others have shown that cognitive radios operating in CMRS bands will cause interference. Yet the Commission proposes not only to permit the use of cognitive radio devices in the CMRS bands, but also to permit higher power operation for all unlicensed devices. It specifically asks whether it should amend Section 15.209, which permits unlicensed devices to operate at very low power in all but television broadcast and certain designated restricted bands, to permit operation at higher power levels.[10] Whatever else the Commission should do in this proceeding, it should not alter these power levels. CMRS licensees have repeatedly placed evidence on the record that shows that their systems and thus their customers' connections are very sensitive to external interference from sources such as unlicensed devices.[11]

The Cognitive Radio NPRM Ignores Economic Analysis. The NPRM treats the invasion of licensed spectrum purely as a technical interference issue and ignores evidence that its sharing schemes will increase interference in licensed bands. The allocation of rights to use resources such as spectrum, however, is also an economic issue. "Forced sharing," as proposed in the both this *NPRM* and the *Interference Temperature NOI*, fails basic economic principles and cost-benefit analysis. The Commission proposes to invade licensed bands for the benefit of other businesses, specifically asking whether its proposed higher levels of power operation "are

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[10] *NPRM* at ¶ 41. The *NPRM* also proposes to increase the power limit for spread spectrum devices operating under Sections 15.247 and 15.249 of Part 15 of the Commission's rules by up to 6 times (for approximately an 8 dB increase). The NPRM does not propose to change the harmonic and out-of-band (OOBE) emission limits that are set forth in Sections 15.247 and 15.249 of the rules, which may present a problem for nearby services such as MDS in the 2500-2690 MHz band (next to 2400-2483.5 MHz ISM band) and 800 MHz cellular (near the 902-928 MHz). Specifically, the OOBE limit for devices operating under Section 15.247(c) is set at 20 dB below the in-band power. Thus, if the in-band power increases by a factor of six, so does the permissible spurious emission limit, which may be objectionable. *Id.* at ¶ 42.

[11] *See, e.g.,* V-Comm Comments.

sufficient to be of benefit to WISPs, wireless LANs or other unlicensed operations in areas with limited spectrum use."[12] The Commission itself makes no finding that these WLANs or WISPs will produce economic value comparable to that of the licensees who currently use the spectrum, or cannot use current unlicensed bands or bid at auction for new licenses. On the other hand, where demand for spectrum is limited, spectrum values are likely to be low. And regardless of whether spectrum is cheap or expensive, if a WISP can produce an economically viable service, it will have every incentive to get spectrum it needs even if – like Verizon Wireless – it must put a dollar value on that spectrum.

Rigorous, defensible economic analysis is an essential predicate to reversing the Commission's long established policy giving licensees the right to fully mine the spectrum allocated to their licenses – policy that existing licensees have relied on in making the multi-billion dollar investments in spectrum, R&D, network equipment, customer handsets and service development that have spurred innovation and created a robust, vibrant, fast-growing market for wireless services.

This policy approach has been successfully tested.[13] CMRS licensees have created exponentially far more economic value per MHz than competing services. CMRS licensees serve more than 160 million customers with wireless voice and data services on a narrow sliver of roughly 190 MHz of spectrum. These licensees spend over $20 billion annually on building network infrastructure and their customers spend billions more per year on handsets and

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[12] *NPRM* at ¶ 41.

[13] Hazlett and Spitzer at 41. "[T]he FCC, rather than seeking to construct experiments, should first recognize the factual record that exists. Exclusively-assigned, flexible-use spectrum rights have demonstrably achieved … innovative band sharing. . . . This record includes the ability to upgrade technologies, to relocate users, and to effectively economize on the use of radio spectrum. Before embarking on more limited tests, the Commission should seek to incorporate these far-reaching marketplace results in its analysis."

service.[14] Furthermore, licensed CMRS providers are rolling out the only nationwide broadband services.[15] Some estimate that CMRS licensees have created $900 billion in consumer benefits.[16] In contrast, economic activity in unlicensed bands appears to offer far less value to consumers.[17]

If new cognitive radio technologies arise that make more efficient use of spectrum, licensees have every incentive to adopt them. The Commission approvingly cites the work of the DARPA NeXtGeneration (XG) program and its goal to "increase spectrum efficiency by a factor of 10,"[18] but DARPA's work provides no basis for invading licensee rights. Given the billions that carriers currently pay for spectrum, licensees will welcome DARPA's technology if it substantially reduces the need to buy new licenses. Indeed, such technology adoption would simply further the industry's efforts to maximize spectrum efficiency. According to CTIA, in 1990 a 10 km analog cell site would have averaged fewer than seven subscribers per MHz. In 2003, in the same 10 km area, wireless averaged just under 500 subscribers per MHz,[19] an increase in efficiency by a factor of more than 70. This seventy-fold increase does not even reflect the more than fourfold increase in the average minutes of use of each subscriber.

One danger of forced sharing regimes in an exclusive, flexible use licensing regime is that licensees will have little if any incentive to deploy spectrally efficient technologies if an

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[14] *See* Cellular Telephone and Internet Association ("CTIA"), *Background on CTIA's Semi-Annual Wireless Industry Survey* at http://wow-com.com/industry/stats/surveys/.

[15] "Verizon Is Crossing The U.S. With Speedy, True Wireless Access," *Wall Street Journal* (Apr. 8, 2004) at B1.

[16] Hazlett and Spitzer at 33.

[17] *Id.* at 30.

[18] *NPRM* at ¶ 16.

[19] CTIA Comments to *Interference Temperature NOI* at 5.

underlay or easement is not under the licensee's control, since any future increases in a *licensed user's* efficiency yield benefits for the *unlicensed* users in the band. Further, licensees face additional injuries associated with such increased interference, of either decreased service levels or increased costs simply to maintain the same level of service.[20] Finally, the presence of unlicensed users and whatever sharing rules the FCC selects would bound the licensee's technology, making it difficult for the licensee to continue to deploy more advanced systems that bring far more agility. Regulation would replace market competition in setting cutting-edge wireless applications. As advanced as a particular government rule may appear when created, it will become difficult to change and will hamper innovation, just as surely as rigid block allocation rules have in the past.

II. The Commission Can Best Promote Opportunistic Devices by Strengthening Licensee Rights

The appropriate way to increase "flexible, efficient and reliable spectrum use" is for the Commission to reaffirm and strengthen - rather than abandon - its successful policy of giving licensees exclusive and flexible use of their spectrum. The Commission said in the *Secondary Markets Further Notice* that it intends to "focus on advancing and improving a secondary markets approach to access to spectrum by opportunistic devices."[21] To establish a functioning secondary spectrum market, the Commission must give licensees control over third-party opportunistic devices in their licensed spectrum. The concept of allowing unlicensed cognitive radios to transmit in licensed bands conflicts with one of the goals of the secondary markets

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[20] Hazlett and Spitzer at 36-41.

[21] *Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets,* WT Docket No. 00-230, *Report and Order and Further Notice of Proposed Rulemaking*, 18 FCC Rcd. 20604 (2003) at ¶ 234 ("*Secondary Markets Further Notice"*).

initiative. A licensee facing greater interference from unlicensed transmitters will have less incentive and ability to resell spectrum. As a prospective lessee, why pay for rights to use spectrum that can be exploited for free or when Commission sharing decisions may render the space crowded? Instead, the Commission's policies should encourage exclusive licensees to mine their spectrum efficiently in order to free up more of their spectrum for lease, thereby promoting additional productive activity.

In addition to clarifying the rights and responsibilities of spectrum licensees, giving licensees the exclusive right to negotiate agreements to offer easements or underlays to its spectrum, the Commission should adopt rules that would enable leasing transactions using cognitive radios. The rules currently require that the lessor and lessee report to the Commission the geography and the frequencies that will be used. "Smart" or "opportunistic" cognitive devices are agile and operate in locations and frequencies that are open, not in those that have previously been defined in any concrete way. Thus, to encourage the use of smart radios on licensed spectrum, the most useful thing the Commission can do is to let licensees and secondary users enter into any arrangements that make economic sense. The Commission also should rescind its reporting requirement on secondary leases for cognitive radio uses, since such use would be sporadic, ancillary to the main operation of a licensee, and in many cases, as described in the Jackson Declaration, under the complete technical and legal control of the licensee.[22]

III. The Commission Must Carefully Consider How to Permit Cognitive Radio Devices in Unlicensed Spectrum

For spectrum leasing, the Commission should not dictate any of the technical requirements for cognitive radio technology, but operate under the same flexible technology

[22] Jackson Declaration at 16.

standards that have led to considerable innovation in the CMRS bands. In unlicensed bands, however, the Commission must require standards and must require testing to ensure compliance with the standard. Unlicensed devices not under common control of a licensee nor traceable through a Commission license are difficult to remove from use once deployed.

The reaction to the Commission's "spectrum etiquette" proposal to control access to unlicensed bands illustrates the problems with promoting cognitive radios as the "next big thing."[23] With spectrum etiquette, a device would "listen" and wait until conditions allow transmission. As such, it is a simple form of cognitive radio, even though it does not find available spectrum, retune or change other operating parameters. Yet, many parties to that proceeding opposed establishing an etiquette.[24] Unlicensed device manufacturers gave numerous reasons why the Commission's spectrum etiquette was impractical, including the cost of producing such equipment, the lack of success of similar efforts in the past, and the threat to innovation. Most importantly, perhaps, commentators noted unscrupulous operators might use cognitive radio to hog or "squat" on the spectrum, which suggests there may be problems with enforcing a cognitive radio approach among unlicensed, uncoordinated users. Certainly these issues would also arise if unlicensed users were to share licensed spectrum on an involuntary basis.

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[23] *Modification of Parts 2 and 15 of the Commission's Rules for Unlicensed Devices and Equipment Approval,* ET Docket 03-201, *Notice of Proposed Rulemaking*, 18 FCC Rcd. 18910 (2003) ("*Unlicensed NPRM")*

[24] *See, e.g.,* Comments of Intel Corporation at 6-7 (spectrum etiquette might lead to manufacturers to design devices that would "squat" on frequencies and foreclose future unlicensed users); Comments of Pegasus Technologies (imposing an etiquette on existing bands will greatly limit the future of the bands -- additional complexity is not warranted); Comments of IEEE 802 at ¶ 23 (the concept is simple, but the realization is difficult); and Comments of Globespan Virata, Inc. at 15 (Etiquette should be left to industry, too costly if required or FCC specified) to *Unlicensed NPRM* (all filed Jan. 23, 2004).

IV. Conclusion

The Commission should terminate its inquiry into whether it should allow "non-voluntary" invasion of spectrum licensed on an exclusive, flexible use basis and increase permitted unlicensed power levels in licensed bands. If it truly wishes to promote cognitive radios, the Commission should reaffirm protections for licensees against interference and give licensees further flexibility to lease or "share" spectrum under the Secondary Markets initiative.

Respectfully submitted,

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